Observing Architectural Design: Improving the Development of Collaborative Design Environments.

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Abstract. The physical environments in which design collaborations take place provide many affordances, which enable interactions to occur both seamlessly and (in most cases) successfully. Physical collaboration is also facilitated through many aspects of the design process. Virtual design collaboration on the other hand, while successful at achieving the direct representation of activity around the artefacts being manipulated, lacks many of the physical affordances which make collaboration in the physical realm successful. The aim of this paper is to present the physical affordances of design interaction, isolate those which aid the success of physical design and identify which factors are potentially beneficial to improve the affordances of virtual collaborative design environments.

Introduction

An observational study of physical design was undertaken aimed at exploring the nature of collaborative interaction in the design industry. The occurrences of key aspects of design interaction are explored through design process of architectural firms. By viewing the interactions of designers, workplace settings and styles, this study explores the nature of design communication, considering issues of sketching, creativity, gesture, recruitment and movement across mediums. This analysis, we can begin to inform virtual interaction about the driving elements which control the collaborative design process and begin to explore how these key factors can be harnessed to form a framework to guide virtual collaborative design in the future.

Collaboration in Design

The study discussed in this document took place in 2002/2003 in two different architecture offices. The aim of the study was to gain some insight into the physical design collaboration taking place in the two offices, as part of a broader project to inform the development of collaborative virtual design environment. The intention was to use this as an initial scoping study to identify the key research questions to address during further follow up studies. The longer-term aim is to utilise the detailed analy-

sis techniques of ethnography to inform design decisions based upon our observations.

Observational analysis, and ethnography in particular, has over the past ten years continued to be a very popular method for understanding human activity in context in Human–Computer Interaction (HCI) and Computer Supported Cooperative Work (CSCW) due to its ability to capture detailed insights into user's requirements and into the interconnection of the activities and social environments [5]. However, the approach also has its limitations as it is not rare to see ethnographical analysis last months or even years. In our case the time allocated didn't allow for the use of such extended periods of fieldwork. We therefore followed a 'quick and dirty' approach to using ethnography in the design process [11].

Collaborative virtual design has long been explored in the context of the architectural [7, 9] and CSCW [4, 6]. Studies in capturing the essence of sketching in conceptual design phases have been conducted, but many stop before exploring situated actions in design firms[8]. Commercial development of collaborative design tools and computer aided design (CAD) while making large advances in visualisation and process, have limited coverage when it comes to exploring social structures and surrounding interactions across everyday practice beyond the computer.

Settings – Work, Practice & Social

This preliminary research was conducted in two Brisbane architectural firms over a six-week period from December 2002 to January 2003. During this period we were able to capture data about the process and practice of those firms as well as their physical work settings. Video-cameras were utilised to enable the review of our observations after the study [12, 15]. Interviews with the office staff were also conducted to establish their view on workplace process, practice and interaction with colleagues. The interviews allowed the fieldworkers to ask questions arising out of the study and to clarify details of observed interactions where necessary.

Each of the firms were of a comparable size and organisational structure, and were observed for a total of two days each. Two fieldworkers were used together, one directing the video camera, and the other recording initial observations and pin pointing interactions for later analysis in the office environment. The scale of this study has allowed for an appropriate scope of initial observation into practices and processes of the two design firms. The aim is to 1.) gain a more accurate understanding of the collaborative themes and issues arising from design workplace environments. 2.) Isolate key aspects of interaction in the design environment for further detailed analysis.

The firms each consist of 15 - 18 people with the organisational break-down between the different roles shown in Figures 1 & 2. The two firms were found to be very similar in structure. The project architects (PA) are in charge of guiding the design and dealing with the client. They are rarely involved with computer drawing as they mainly direct projects and work. The student architects (SA) are required to assist the project architect in their work, providing helpful support in CAD, research and documentation. The two Managers/Project architects have a key role in the organisation, overseeing every important decision made in a project. They organise the workflow within the company and also ensure that the coherence of the design approach is in line with the firm's ideologies. In Firm A, the landscape architects have a

very separate role to the other architects. They are often working on a different project that has no connection to the PA's projects. Interior designers in Firm B have a different role, where they are commonly integrated into projects managed by PA's.

Both firms have a profusion of books, samples, magazines of architecture lying on shelves or desks all throughout the office. The use of such documents was observed throughout the period of observation on numerous occasions. They were typically used to inform the designs or support detailed discussion with colleagues and/or clients. These documents also contain the rules, norms and regulations relative to architecture in order for the designer to refer to them if necessary.

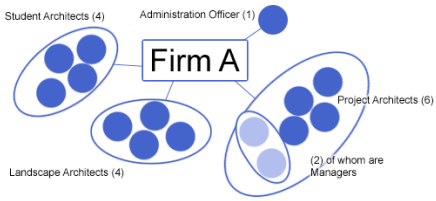

Fig. 1. Firm A Organisation Overview

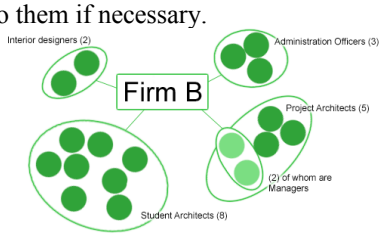

Fig. 2. Firm B Overview

The office layout of the Firm A is open plan, with no high walls blocking the sightlines and the workstations facing the rest of the room as much as possible. The desks are fairly busy with many documents apparently ready for quick consultation. Those documents include plans, printouts, catalogues, samples of material or items, and magazines. Each desk is also equipped with a phone and every computer is connected to the Internet for email etc. On the other hand, Firm B has a more enclosed space with three main zones: the project architects (PA); the "CAD pit" where the student architects (SA) are situated; and the managers-partners who are isolated from the rest of the office by two big shelves. This physical organisation tends to reflect the working processes utilised by the managers, where they play a more formal role in their interactions on projects rather than becoming engaged in chance informal discussions on the development while passing a fellow office worker.

Work styles

Generally, the work is conducted following a series of actions described in Figure 3. The first idea is sketched on paper in groups from the information gathered by the PA in charge. Those come from the notes and sketches of the PA on site as well as the specifications and preferences given by the client.

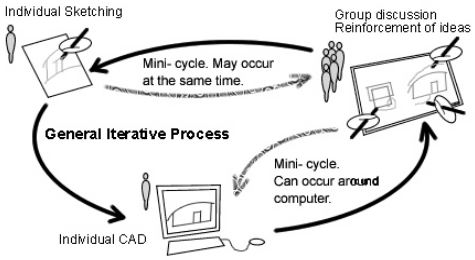

Fig. 3. Iterative tasks for design

This iterative process of design has been well documented in practice [10, 16]. From the initial sketch, a first design is implemented either on computer or as a 3D physical model. The 3D physical model views the building as a volume, for itself or its surroundings, for the purposes of initial volumetric studies. The importance of artefacts such as CAD models for informing design and discussion about the attributes of a project have been explored in other studies of architects. CAD was shown to be effective for both exploring the perception of the problem space in a tangible three-dimensional format, and portraying the interactions between design elements through the artefact to participating group members [13]. The interactions explored throughout this study have been chosen to assist in providing coverage of all stages of the process outlined.

Outcomes and analysis

The fieldwork revealed several key aspects of interaction inside the constraints of the design process and the architectural office environment. Through the analysis of the video footage in both firms interaction, several key interaction styles have been revealed. While they are not the sum total of all interactions occurring within the various office environments, they do encapsulate the focus of interactions occurring through the environment, for the purposes of informing further detailed interaction analysis. A full analysis has been documented in the project technical report [14] The interactions have been grouped into the following categories to enable classifications of collaboration to occur more freely.

1. Interacting in and through the physical environment,
2. Recruitment/interaction by circumstance (whether proximity or chance contact),
3. Informing interaction with externalised artefacts,

Interacting in and through the physical environment

To assist in understanding what makes physical collaboration important to designers, interviews were conducted, revealing the following. The ability to communicate effectively and efficiently through a common set of values, as in a familiar environment, creates an atmosphere/ambience where people are comfortable with each other. Solid working relationships are established and from this a mini society is born that manifests itself through shared language, common symbolism and design identity. The use of pre-established and recognisable symbols in design work has been explored by Do and Gross. They examined the types of symbols designers use to display various types of information, exploring how designers identify the types of drawing identifier, relators and modifiers required [9]. The social aspects of the office, together with a saturation of contextual information, provide ambience, which creates common focus and generates inspiration. Communication is of course a key part of collaborative design and the ability to effectively convey ideas through verbal and visual means is essential for all staff: *"Its all about me being next to this person and that person ... It's all about the team."* [Manager of Firm A]

The creation of strong working relationships is reliant on trust and commitment and essential for successful collaboration. In face-to-face situations people instinc-

tively attend to other people around them, assessing body language, attitude, and other visual and verbal cues to determine credibility. Proximity to colleagues provides security, generates atmosphere and fosters collaboration and discussion. By being centrally located, co-workers are immersed in a setting that encourages design and this shared context of work style and influences gives context to communication.

The nature of the open plan office environment and multiple staff working cohesively on various sections of projects, results in numerous collaborative interactions over the course of the project. This key interaction encapsulates a considerable amount of the office activity, especially during the early stages of design when the process tends to be conceptual and paper based. A typical example of this grouping of interaction is outlined in Figure 4 below.

Fig. 4. Conceptual design interaction sequence (physical means)

Figure 4 shows where staff (SA, PA and manager) have come together to discuss the conceptual design of a project, The series of images above reveals the combination of group sketch oriented discussion on a central artefact (a), individual work in own notebooks/drawings (b), and annotation of a staff members drawings (c).

Recruitment/interaction by circumstance

Proximity to colleagues also allows for quick access to implicit knowledge and extended personal networks, and promotes an awareness of projects around which allows knowledge sharing despite not being directly involved. It encourages spontaneity and informality in interactions, creating an atmosphere where people feel comfortable about expressing ideas and asking for criticism. This is shown through interactions whereby staff discuss items across the room to those within eye contact, and those who are engaged in a different task who move within proximity of others, with whom they are working on other jobs and change focus to them. This style of chance or unplanned interaction was frequently observed in both firms.

Backhouse and Drew [2] have explored similar issues, which they refer to as 'recruitment' in interaction. This is where an object (or person) seeks and initiates and engages with another. In the case of the firms analysed, recruitment generally occurred when an individual was conducting an activity away from their personal work environment and moved past another staff member's work space, who 'recruited' them to a current task. While this action is considered a deliberate engagement of the first party, it is seen as a flexible interaction in which the affected parties have engaged in interaction before returning to their initial activities [2].

The impromptu interaction observed in both firms was highly valued, with many believing the teamwork would suffer if they were remotely located. This reflects findings from a study of mobility in a product design firm which had offices in different geographic locations, and the impact this had on design teams [4]. It was found, that while colleagues situated in one office communicated more effectively and had a

greater awareness of projects conducted within that office, communication and awareness between geographically separate offices suffered. They suggest that, "Informal and frequent interactions seem to be critical to the way the organisation conducts its work as a whole" [4]. In relation to remote collaboration, the little questions between co-workers would be the hardest to support, requiring the facilitation of real time, synchronous communication of a visual nature. Being able to quickly consult colleagues greatly shortens the design process, and minimises interruptions to the flow of the creative process. If forced to conduct such communication via asynchronous mean such as email, however, waiting for a reply even for a simple question by its very nature wastes time and disrupts the work flow. One participant stated when asked about working remotely and not having face-to-face contact with colleagues: *"...you couldn't share a coffee with them"* (Firm A worker) Proximity also facilitates awareness of body language and non-verbal cues when communicating with colleagues. The following footage (Figure 5) demonstrates an external physical cue resulting in spontaneous interaction between two staff members.

Fig. 5. Recruitment and chance interaction sequence

Here the act of one staff member (A), wandering past one part of the office, results in another staff member in close proximity (B) to look up. This action results in B engaging A in discussion about her current project, drawing her away from her immediate task and temporarily being recruited to the new activity.

Gesture & Externalised Artefacts.

Gestures are frequently used to communicate concepts and ideas in conversation, and body language often provides physical clues as to a person's state of mind. Much of the problem with current distributed collaboration is that the lack of non-verbal cues and social context makes it difficult to gauge the mood of the person they are trying to communicate with [3, 4]. Gesture as a communication tool has a number of characteristics and uses as described by Bekker et al., through the outcomes of their study into face-to-face gestures and their use in design situations. Four major categories of gesture were defined, these being: *spatial*, where movement indicates distance, location or size; *kinetic*, describing actions or series of actions; *points*, pointing with a finger usually at an artefact or person; and *other* [3]. All of these types of gestures were observed in the collaborative interactions of the architects, as a tool for explanation and reinforcement of design. Instinctive and sometimes unconsciously made, gestures synchronise with speech and often occur in a spatial context to surrounding artefacts, people and activities. It is this spatial context in relation to physical artefacts with which we are interested in this point. The interaction outlined below (Figure 6) demonstrates one such example of utilising external artefacts. The nature of gesture can relate to these artefacts as shown below.

Fig. 6. Sequence of interaction utilising gesture and external artefacts

The sequence begins with three staff - the desk owner, SA (C), the PA (A) and the manager (B). Discussion surrounds a set of plans and involves the sourcing of a material for the project by viewing various catalogues (external artefacts). Once a suitable element is found discussion is shifted from the physical artefact to the computer on the desk. This involves the viewing of the project CAD drawing to identify the details of the artefact integration and confirm the suitably for the project. This results in the manager following up with a new artefact (catalogue) to provide further design options to the SA.

Many gestures can convey complex messages in a single hand movement, such as action, three-dimensional objects and to describe past events [3]. This interaction shows one such example of how a slight of hand can change the focus from project drawings, to catalogue to computer in a faction of a second. You can see the staff's focus change in time with these gestures.

Conclusion

Through the course of this paper we have discussed the observations from key interactions in the design processes in two architectural firms. The complex process of design and individualised interaction is revealed to be as involved as the social and physical context in which it was observed. Exploration of this social structure of design firms has been demonstrated as integral to design interaction.

In undertaking this study, we recognise the great difficulty in replicating the affordances of physical interaction when implementing virtual collaboration and design tools [1]. Rather, this study is part of a process of understanding how we can improve our understanding of those physical affordances so as to develop better tools for virtual or remote interaction in design, whilst also attending to the ease in which designers can switch between the two mediums.

The study reported here has identified recruitment, chance interaction, physical artefacts, and cues and gestures as key interactions. This can now form the starting point for more detailed and focused fieldwork and analysis for the purpose of directly informing the development of collaborative design environments. The context observed through these interactions is an example of where virtual design collaboration as a field can benefit from such studies. While the physical interactions are not necessarily applicable in all design settings, the further detailed observational analyses in key interactions will consider not only the intricacies of physical and virtual interaction, but also the nature of situated actions, which affect the flexibility of day to

day design firms process. Ultimately, our improved understanding from conducting studies such as this will inform how they can be applied in the virtual realm.

Following on from this study will be a series of more focused ethnographic observations. These will be targeted towards the generation of a framework that can be used to inform the development of collaborative virtual design environments. The success of this work will ultimately depend on the ability of such environments to support the key interactions identified here. At the same time, it is important to recognise that virtual design environments must support designers in making transitions between physical and virtual representations and interactions. Ultimately sensitivity is required to designers' established work practice so that developed systems are more readily appropriated into the everyday practice of the designers.

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